Summary of Activities in 2004-05 and Plans for 2005-2006

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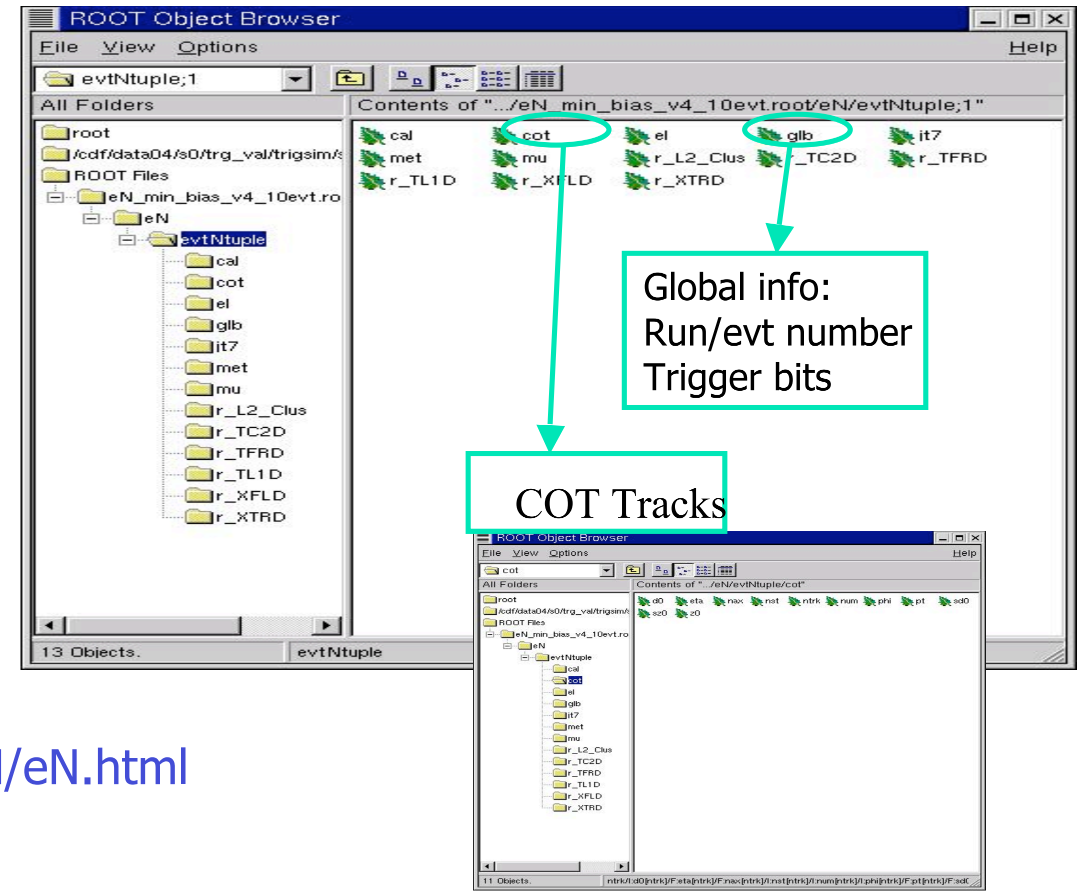
Outline

- CDF activities
  - Service work
  - Physics analysis
    - Search for LeptoQuarks: 1st and 2nd generation
    - Search for LeptoQuarks: 3rd generation
- ATLAS
  - Physics Analysis:
    - Single Top
    - Leptoquarks
- Miscellanea (talks and presentations)

Service work at CDF

CDF eventNutple - eN

- Event information is translated into ROOT branches:
  - High Level Objects
  - Trigger Information
  - Raw Data Information
  - Simulated information



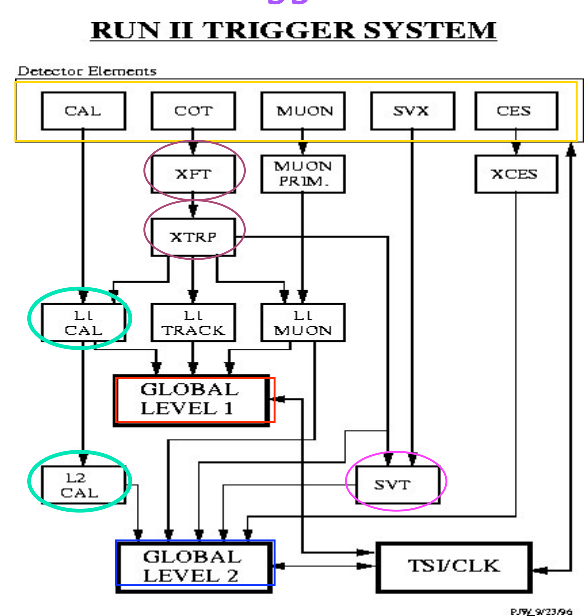
eN is one of the three main analysis tools used in CDF

http://ncdf70.fnal.gov:8001/talks/eN/eN.html

Service work at CDF (cont'd)

TRGSim++

- set of (C++) packages which emulate the various trigger levels decision steps (CDF trigger is fully digital)
  - offline tool to calculate rates and efficiencies;
  - online monitoring tool.
- TRGSim++ modules run off detector raw data and produce emulated trigger data identical to real hardware data.
- Trigger decision steps: A_C++ modules, organized in packages:
  - CalTrigger
  - MuonTrigger
  - XFTSim
  - SVTSim
  - XTRPSim
  - L2/L1GlobalTrigger
  - TriggerMods
  - TriggerObjects



http://ncdf70.fnal.gov:8001/trigsim/trgsim.html

Service Work (Cont'd)

- CDF is producing a great amount of papers
  - Internal review committees are set for each analysis
    - Still some Run I analysis
- I was godparents committee chair for 2 analysis:
  - Search for ZZ and WZ production in pp collisions at $\sqrt{s}$ = 1.96 TeV
    - leptonic decay channels , and ZW→ *l1ll and llνν*. In a 194 pb-1 data sample collected at the collider detector at Fermilab, 4 ZZ and ZW candidates are found with an expected standard model background of 2.29 ± 0.42 events. 95% CL limit set on the production crosse section.
    - Published in Phys. Rev. D71, 09115 (2005)
  - V+A Fraction in Top Decay at CDF at $\sqrt{s}$ =1.8 TeV
    - Measurement of the decay rate f_{V+A} of W produced in top decayin the hypothesis of a non standard V+A structure of the tWb vertex. f_{V+A} < .61 at 95% CL
    - Published in Phys. Rev. D71, 031101(R) (2005).

Searches for LeptoQuarks

- Why Leptoquarks ?
- Current Results
  - First and Second Generation Leptoquarks
  - Final Run II results
  - Comparison with LHC prediction
- Future plans
  - Third Generation: τ

Theoretical Motivation

- **Leptoquarks (LQ)** are hypothetical particles which appear in many SM extensions to explain **symmetry between leptons and quarks**
  - SU(5) GUT model
  - superstring-inspired models
  - 'colour' SU(4) Pati-Salam model
  - composite models
  - technicolor

•**LQs can have**:

–spin 0 (scalar)

•couplings fixed, i.e., no free parameters

•Isotropic decay

–spin 1 (vector)

•anomalous magnetic (k_G) and electric quadrupole (λ_G) model-dependent couplings

–Yang-Mills coupling: $k_G = \lambda_G = 0$

–Minimal coupling: $K_G = 1$, $\lambda_G = 0$

–Decay amplitude proportional to $(1 + \cos\theta^*)^2$

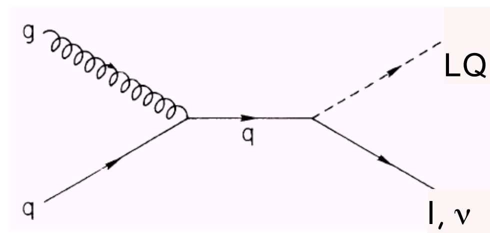
•LQs are **coupled to both leptons and quarks** and carry SU(3) color, fractional electric charge, baryon (B) and lepton (L) numbers

- **Experimental evidence searched:**
  - indirectly: LQ-induced 4-fermion interactions
  - directly: production cross sections at collider experiments

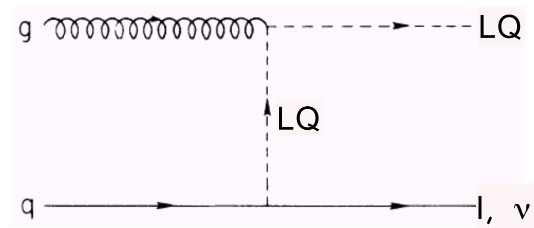
LQ at Hadron Colliders

- **Single production**
  - strongly depends on λ
  - possible signatures:
    - l^+l^- + jet
    - $l\nu$ + jet
    - $\nu\ \nu$ + jet
  - Main background: Zjet & tt

$qg \rightarrow \ell\, LQ$,



$qg \rightarrow \nu\ LQ$

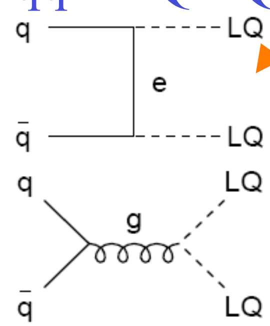


Not considered here

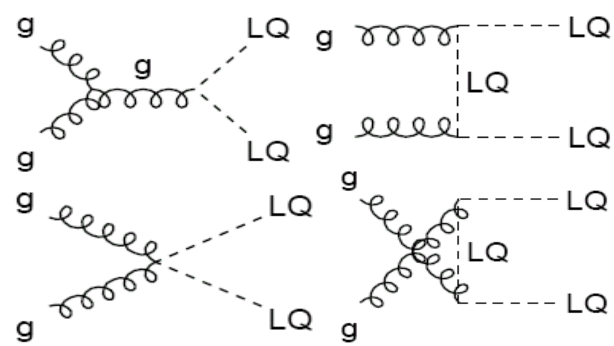
- λ dependent process
- does not contribute significantly to 2nd & 3rd generation

- **Pair production**
  - Practically independent of Yukawa coupling λ (only g-LQ-LQ vertex)
  - Depends mainly on LQ mass

$q\bar{q} \rightarrow LQ\ LQ$



$gg \rightarrow LQ\ LQ$



LeptoQuark Decay

$b = Br(LQ \to lq)$

Each generation can decay into 3 final states:

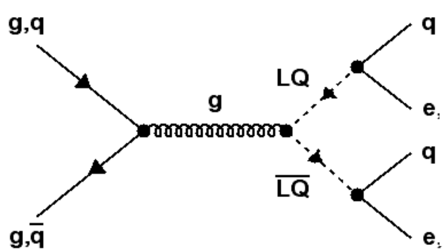
Exclusive to the Tevatron

	1^{st} Generation	2^{nd} Generation	3^{rd} Generation
$\beta = 1$	$LQ\,\overline{LQ} \to e^- e^+ q\bar{q}$	$LQ\,\overline{LQ} \to \mu^+ \mu^- q\bar{q}$	$LQ\,\overline{LQ} \to \tau^+ \tau^- q\bar{q}$
$\beta = 0.5$	$LQ\,\overline{LQ} \to e^{\pm} \nu_e q_i q_j$	$LQ\,\overline{LQ} \to \mu^{\pm} \nu_\mu q_i q_j$	$LQ\,\overline{LQ} \to \tau^{\pm} \nu\, q_i q_j$
$\beta = 0$	$LQ\,\overline{LQ} \to \nu_e \nu_e q\bar{q}$	$LQ\,\overline{LQ} \to \nu_\mu \nu_\mu q\bar{q}$	$LQ\,\overline{LQ} \to \nu_\tau \nu_\tau q\bar{q}$

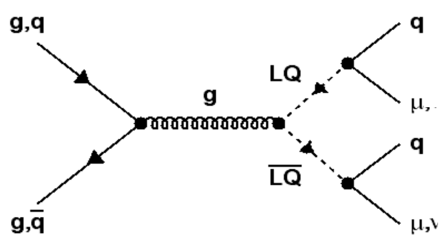
This talk! →

$LQ\,LQ \to llqq$	$2l+2j$	$BR = \beta^2$
$LQ\,LQ \to l\nu qq$	l+MET+$2j$	$BR = 2\beta(1-\beta)$
$LQ\,LQ \to \nu\nu qq$	MET+$2j$	$BR = (1-\beta)^2$

Search for LQ in dileptons + jets (I)

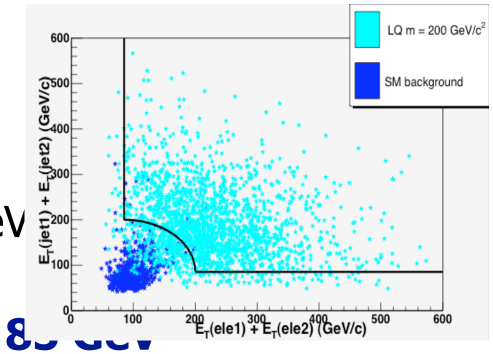


SM background
- Drell-Yan+2jets
- Top ($W \rightarrow e\nu$)
- QCD/Fakes



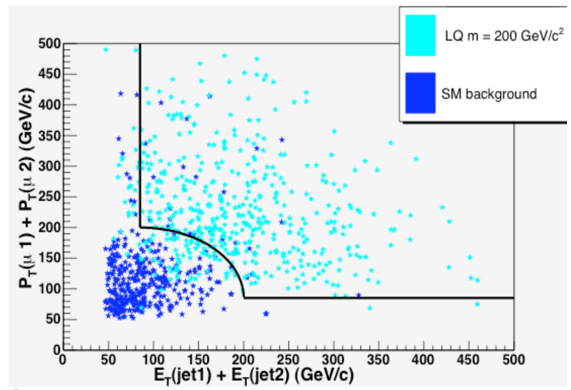
Selection

- ✓ 2 electrons (CC,CF) $E_T > 25$ GeV
- ✓ 2 jets, $E_T(j1) > 30$ GeV, $E_T(j2) > 15$ GeV
- ✓ Z Veto ($76 < M_{\mu\mu} < 110$) GeV
- ✓ **Electrons/Jets: $E_T^{\,j1(e1)} + E_T^{\,j2(e2)} > 85$ GeV**
- ✓ **$\left((E_T(j_1) + E_T(j_2))^2 + (E_T(e_1) + E_T(e_2))^2 \right)^{1/2} > 200$ GeV**



Selection

- ❖ 2 muons with $P_T > 25$ GeV
- ❖ 2 jets with $E_T(j1,j2) > 30,15$ GeV
- ❖ Dimuon Mass Veto:
  - ❖ $76 < M_{\mu\mu} < 110$, $M_{\mu\mu} < 15$ GeV
- ❖ $E_T(j_1) + E_T(j_2) > 85$ GeV and $P_T(\mu_1) + P_T(\mu_2) > 85$ GeV
- ❖ $\left((E_T(j_1) + E_T(j_2))^2 + (P_T(\mu_1) + P_T(\mu_2))^2 \right)^{1/2} > 200$ GeV



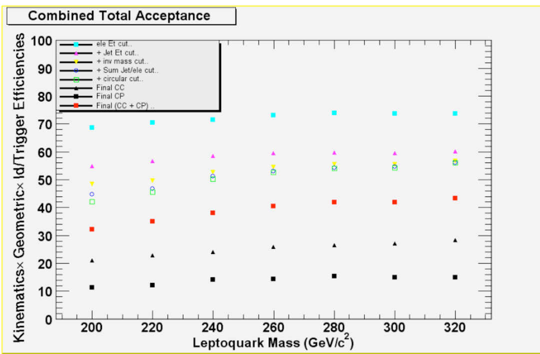
Search for LQ in dileptons + jets(II)

Backgrounds:	eejj	mmjj
Z + 2 jets (alpgen)	1.89 ± 0.44	1.7 ±0.1
ttbar (Pythia)	0.35 ± 0.03	0.22 ±0.03
Fakes (data)	3.96 ± 2.01	1±1
Total	6.24 ± 2.16	3.0 ±1
Observed	4	2

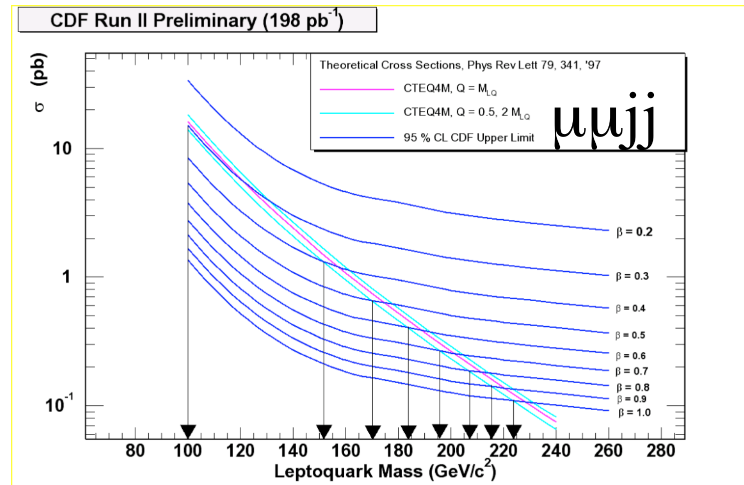
Systematics: signal acceptance and background prediction

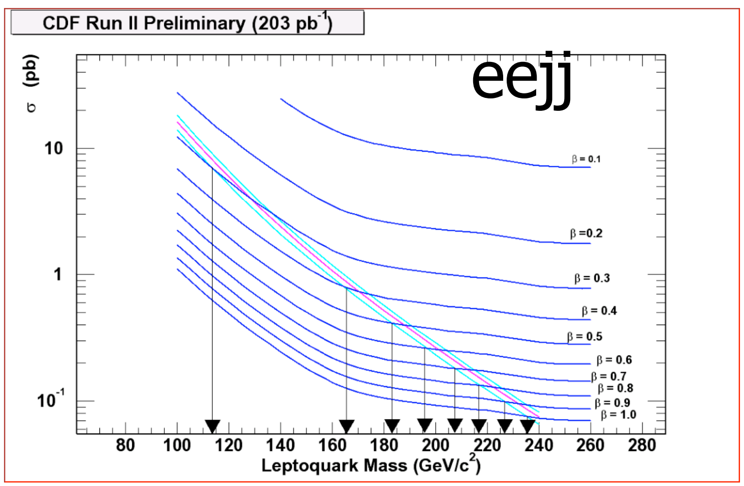
Luminosity	6%
pdf	2.1%
statistics of MC	~1.2%
Jet Energy Scale	<1%
muon reco/ele id	<1%
Z vertex cut	0.5%

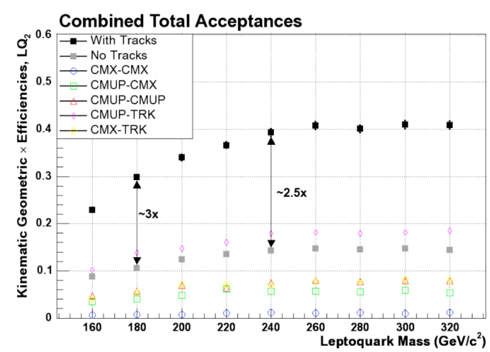
Search for LQ in dileptons + jets (III)



Exclude at 95% CL M_{LQ}<224 GeV/c^2 for β = 1.0







Exclude at 95% CL M_{LQ}<235 GeV/c^2 for β = 1.0

Search for LQ in dileptons + jets (IV)

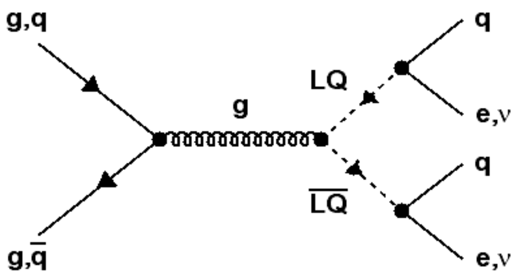
TABLE I: Efficiencies after all cuts, relative errors and 95% C.L. upper limits on the production cross section × branching fraction Br, as a function of M_{LQ}, for the two channels.

$M_{\mathrm{LQ}}(\mathrm{GeV}/c^2)$	$eejj$		$e\nu jj$	
	ϵ	$\sigma\times\mathrm{Br(pb)}$	ϵ	$\sigma\times\mathrm{Br(pb)}$
100	0.07 ± 0.07	1.11	0.02 ± 0.13	5.71
140	0.12 ± 0.04	0.25	0.08 ± 0.09	0.69
160	0.21 ± 0.04	0.14	0.08 ± 0.09	0.65
200	0.32 ± 0.05	0.09	0.16 ± 0.08	0.37
220	0.35 ± 0.05	0.08	0.19 ± 0.08	0.24
240	0.38 ± 0.04	0.07	0.20 ± 0.08	0.23
260	0.40 ± 0.04	0.07	0.22 ± 0.08	0.22

TABLE I: Efficiencies after all cuts, relative errors and 95% C.L. upper limits on the production cross section × branching fraction Br, as a function of M_{LQ}, for the two channels.

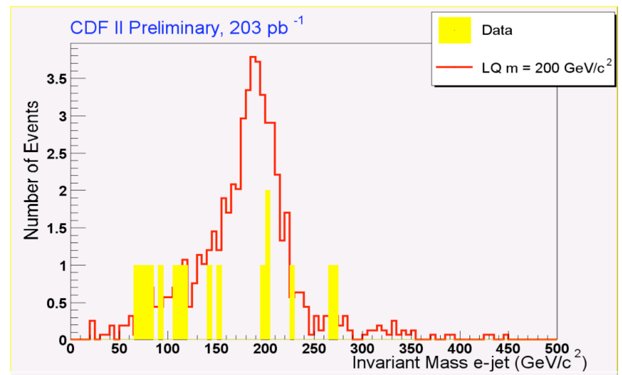
$M_{\mathrm{LQ}}(\mathrm{GeV}/c^2)$	$\mu\mu jj$		$\mu\nu jj$	
	ϵ	$\sigma\times\mathrm{Br(pb)}$	ϵ	$\sigma\times\mathrm{Br(pb)}$
100	0.02 ± 0.17	1.35	0.005 ± 0.10	-
120	0.05 ± 0.09	0.52	0.07 ± 0.07	0.86
160	0.13 ± 0.08	0.18	0.07 ± 0.08	0.73
200	0.19 ± 0.08	0.13	0.11 ± 0.07	0.41
220	0.21 ± 0.08	0.11	0.13 ± 0.08	0.24
240	0.24 ± 0.08	0.10	0.13 ± 0.07	0.24
260	0.26 ± 0.08	0.09	0.14 ± 0.07	0.21

Search for LQ in lepton + MET + jets



Selection

- 1central electrons with $E_T > 25$ GeV
- MET > 60 GeV
- Veto on 2nd electron, central loose or Plug
- 2 jets with $E_T > 30$ GeV
- $\Delta\phi$ (MET-jet) > 10°
- $E_T(j1) + E_T(j2) > 80$ GeV
- $M_T(e\text{-}\nu) > 120$
- LQ mass combinations



SM background

- W +2jets
- Top (l + jets and dilepton)
- QCD/Fakes

Selection

Z veto (tight/loose pair)

No 2nd muon (CMUP, CMX, or stubless)

$P_T(\mu) > 25$ GeV

$\not{E}_T > 60$ GeV

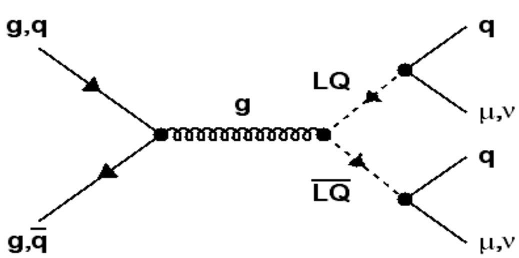
2 jets, @ E_T>30GeV

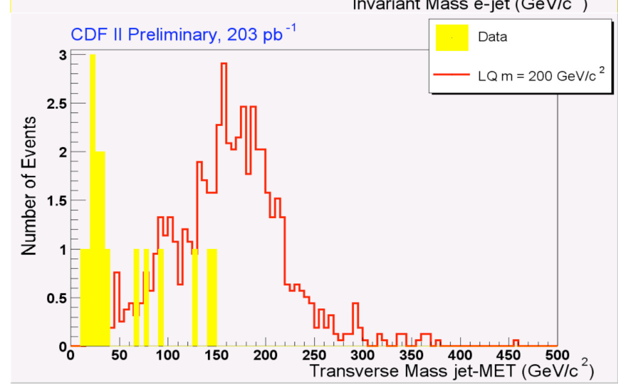
$\Delta\phi(\mu,\not{E}_T)<175°$, $\Delta\phi(\not{E}_T,\text{jets})>5°$

$E_T(\text{jet1})+E_T(\text{jet2}) > 80$ GeV

$M_T(\not{E}_T,\text{Muon}) > 120$ GeV/c^2

Mass Cut

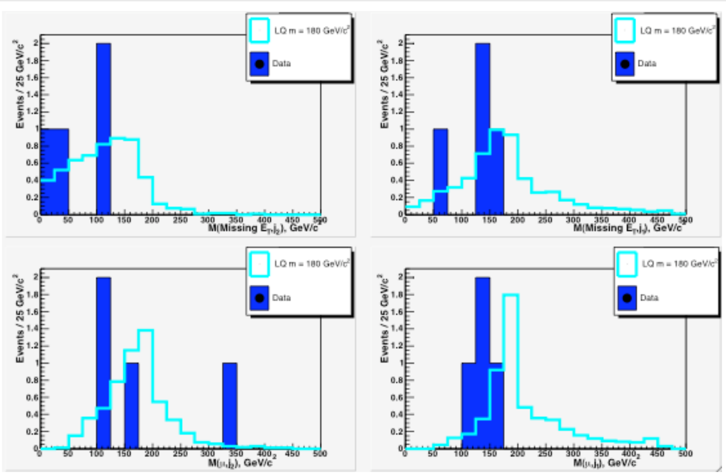




Search for LQ in lepton,MET + jets (II)

TABLE II: Number of events surviving all cuts in the muon, missing energy and jets topology, compared with background expectations, as function of the *LQ* mass (in GeV/c^2). The number for the individual contributions have been multiplied by 10.

Mass	Wjj	top	Z jj	multijets	Total	Data
140	9 ± 1	17 ± 2	2 ± 0.1	3 ± 3	3.1 ± 0.3	3
160	14 ± 1	18 ± 2	2 ± 0.2	3 ± 3	3.7 ± 0.4	4
180	14 ± 1	14 ± 2	2 ± 0.1	3 ± 3	3.2 ± 0.3	2
200	16 ± 1	10 ± 4	2 ± 0.1	3 ± 3	3.1 ± 0.3	0
220	16 ± 1	8 ± 3	2 ± 0.1	3 ± 3	2.9 ± 0.3	0



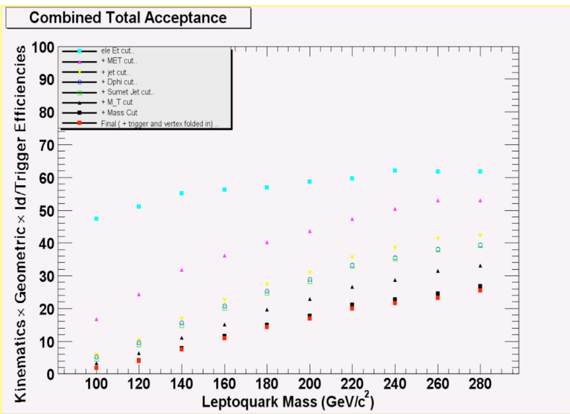
<u>Systematics: signal acceptance and background estimate</u>

Luminosity	6%
pdf	2.1%
Statistics of MC	~1.2%
Jet energy scale	<1%
Muon reco/ele id	<1%
Z vertex cut	0.5%

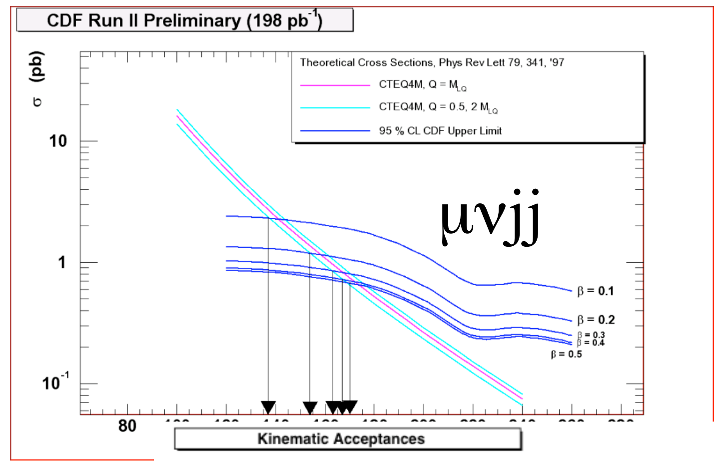
TABLE II: Final number of events surviving all cuts in the electron, missing energy and jets topology, compared with background expectations, as function of the LQ mass (in GeV/c^2).

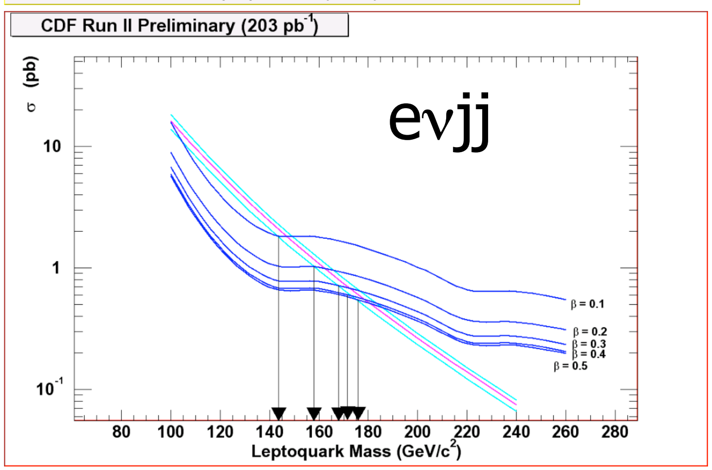
Mass	W + 2 jets	top	Z + 2 jets	Total	Data
120	1.5 ± 0.9	3.3 ± 0.5	0.06 ± 0.01	4.9 ± 1.0	6
140	1.5 ± 0.9	3.1 ± 0.6	0.08 ± 0.02	4.7 ± 1.0	4
160	2.5 ± 1.1	2.8 ± 0.6	0.08 ± 0.02	5.4 ± 1.2	4
180	2.5 ± 1.1	2.4 ± 0.5	0.08 ± 0.02	5.0 ± 1.2	4
200	2.5 ± 1.1	2.0 ± 0.5	0.07 ± 0.02	4.6 ± 1.2	4
220	2.0 ± 1.0	1.6 ± 0.3	0.06 ± 0.02	3.7 ± 1.1	2
240	2.0 ± 1.0	1.1 ± 0.3	0.06 ± 0.02	3.1 ± 1.0	2
260	1.5 ± 1.0	0.8 ± 0.3	0.04 ± 0.02	2.4 ± 0.9	2

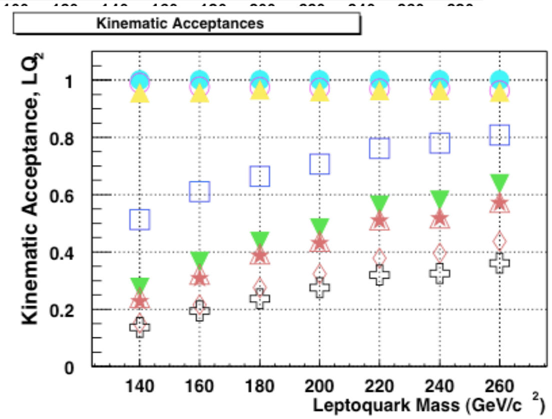
Search for LQ in lepton,MET + jets (III)



Exclude at 95% CL M_{LQ}<170 GeV/c^2 for β = 0.5







Exclude at 95% CL M_{LQ}<176 GeV/c^2 for β = 0.5

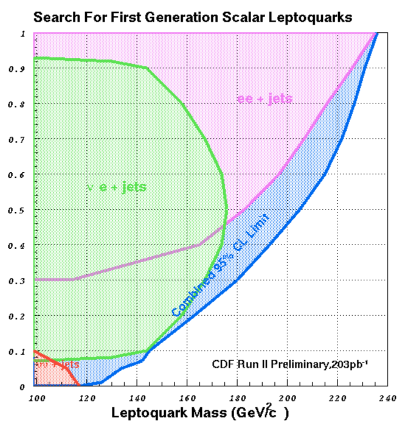
Final Combined Limits

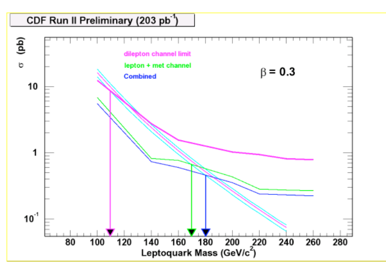
<u>Joint likelihood</u> formed from the product of the individual channels likelihood.
The searches in the dileptons and lepton + MET channels use common criteria and sometime apply the same kind of requirements (for example on lepton identification) so <u>the uncertainties in the acceptances have been considered completely correlated</u> (which gives the most conservative limit).
When calculating the limit combination including also the <u>ννjj channel the uncertainties in the acceptances have been considered uncorrelated</u>.A correlation factor of 0.5 has also been considered (no difference)

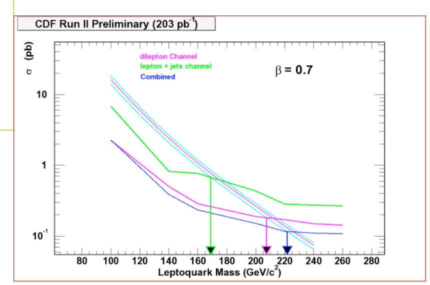
$$\sigma_{LIM} = N_{LIM}/(\varepsilon_{average}\times\mathcal{L})$$

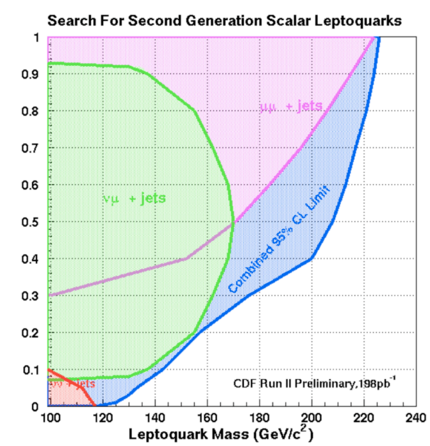
$\varepsilon_{average} = (\beta^2\varepsilon(eejj) + 2\beta(1-\beta)\varepsilon(e\nu jj) + \beta^2\varepsilon(ee\ \mathrm{as}\ e\nu))$ for the 2 channels case and

$\varepsilon_{average} = (\beta^2\varepsilon(eejj) + 2\beta(1-\beta)\varepsilon(e\nu jj) + (1-\beta)^2\varepsilon(\nu\nu jj) + \beta^2\varepsilon(ee\ \mathrm{as}\ e\nu))$ for the 3 channels case.









Final Results

TABLE III: 95% C.L. lower limits on the first generation scalar leptoquark mass (in GeV/c^2), as a function of β.The limit from CDF[7] ($eejj$) Run I ($\sim 120 pb^{-1}$) is also given.

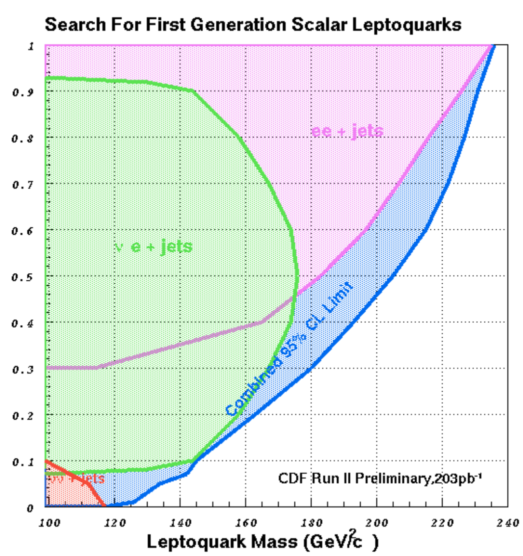
β	ee jj	$e\nu jj$	$\nu\nu jj$	Combined	CDF Run I
0.01	-	-	116	126	-
0.05	-	-	112	134	-
0.1	-	144	-	145	-
0.2	-	158	-	163	-
0.3	114	167	-	180	-
0.4	165	174	-	193	-
0.5	183	176	-	205	-
0.6	197	174	-	215	-
0.7	207	167	-	222	-
0.8	216	158	-	227	-
0.9	226	144	-	231	-
1.0	235	-	-	236	213

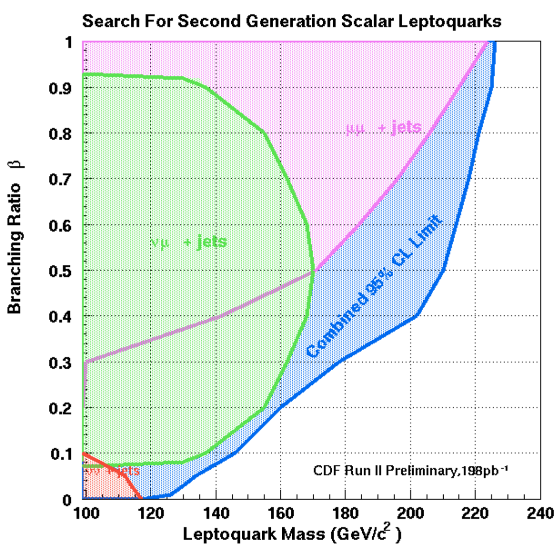
TABLE III: 95% C.L. lower limits on the second generation scalar leptoquark mass (in GeV/c^2), as a function of β.The limit from CDF[4] ($\mu\mu jj$) Run I ($\sim 120 pb^{-1}$) is also given.

β	$\mu\mu$ jj	$\mu\nu jj$	$\nu\nu jj$	Combined	CDF Run I
0.01	-	-	114	125	-
0.05	-	-	110	133	-
0.1	-	137	-	143	-
0.2	-	155	-	157	-
0.3	100	162	-	176	-
0.4	152	168	-	200	-
0.5	171	170	-	208	-
0.6	184	168	-	213	-
0.7	196	162	-	217	-
0.8	206	155	-	221	-
0.9	215	137	-	224	-
1.0	224	-	-	226	202

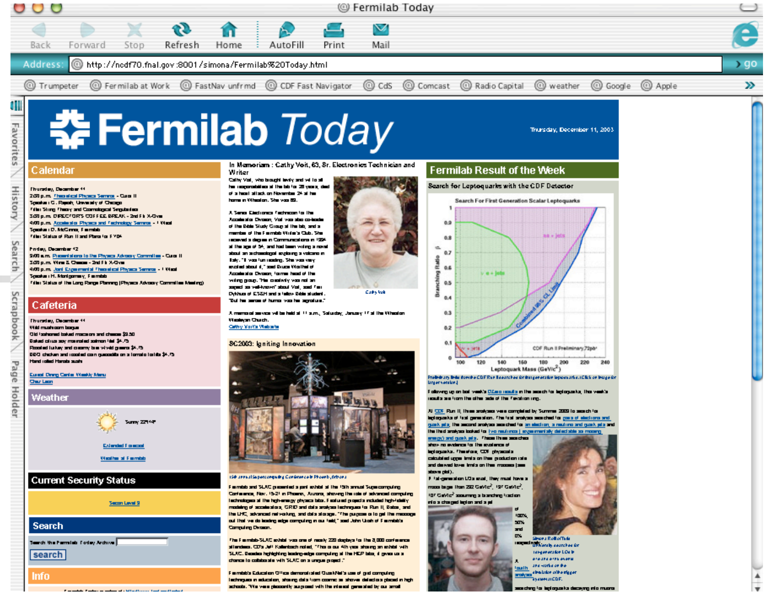
Conclusions on 1st and 2nd gen LQ

- We have performed the combination of all the CDF searches for first and second generation scalar letpoquarks using Run II data.
- The results are combined using a procedure based on a Bayesian approach which takes into account the correlations in the systematic uncertainties.
- We set 95% CL mass limits for scalar leptoquarks as function of β:





Publications



RAPID COMMUNICATIONS

PHYSICAL REVIEW D **72,** 051107(R) (2005)

Search for first-generation scalar leptoquarks in $p\bar{p}$ collisions at $\sqrt{s} = 1.96$ TeV

D. Acosta,[16] J. Adelman,[12] T. Affolder,[9] T. Akimoto,[54] M. G. Albrow,[15] D. Ambrose,[15] S. Amerio,[42] D. Amidei,[33] A. Anastassov,[50] K. Anikeev,[15] A. Annovi,[44] J. Antos,[1] M. Aoki,[54] G. Apollinari,[15] T. Arisawa,[56] J-F. Arguin,[32] A. Artikov,[13] W. Ashmanskas,[15] A. Attal,[7] F. Azfar,[41] P. Azzi-Bacchetta,[42] N. Bacchetta,[42] H. Bachacou,[28] W. Badgett,[15] A. Barbaro-Galtieri,[28] G. J. Barker,[25] V. E. Barnes,[46] B. A. Barnett,[24] S. Baroiant,[6] G. Bauer,[31] F. Bedeschi,[44] S. Behari,[24] S. Belforte,[53] G. Bellettini,[44] J. Bellinger,[58] A. Belloni,[31] E. Ben-Haim,[15] D. Benjamin,[14] A. Beretvas,[15] T. Berry,[29] A. Bhatti,[48] M. Binkley,[15] D. Bisello,[42] M. Bishai,[15] R. E. Blair,[2] C. Blocker,[5] K. Bloom,[33] B. Blumenfeld,[24] A. Bocci,[48] A. Bodek,[47] G. Bolla,[46] A. Bolshov,[31] D. Bortoletto,[46] J. Boudreau,[45] S. Bourov,[15] B. Brau,[9] C. Bromberg,[34] E. Brubaker,[12] J. Budagov,[13] H. S. Budd,[47] K. Burkett,[15] G. Busetto,[42] P. Bussey,[19] K. L. Byrum,[2] S. Cabrera,[14] M. Campanelli,[18] M. Campbell,[33] F. Canelli,[7] A. Canepa,[46] M. Casarsa,[53] D. Carlsmith,[58] R. Carosi,[44] S. Carron,[14] M. Cavalli-Sforza,[3] A. Castro,[4] P. Catastini,[44] D. Cauz,[53] A. Cerri,[28] L. Cerrito,[41] J. Chapman,[33] Y. C. Chen,[1] M. Chertok,[6] G. Chiarelli,[44] G. Chlachidze,[13] F. Chlebana,[15] I. Cho,[27] K. Cho,[27] D. Chokheli,[13] J. P. Chou,[20] S. Chuang,[58] K. Chung,[11] W-H. Chung,[58] Y. S. Chung,[47] M. Cijliak,[44] C. I. Ciobanu,[23] M. A. Ciocci,[44] A. G. Clark,[18] D. Clark,[5] M. Coca,[14] A. Connolly,[28] M. Convery,[48] J. Conway,[6] B. Cooper,[30] K. Copic,[33] M. Cordelli,[17] G. Cortiana,[42] J. Cranshaw,[52] J. Cuevas,[10] A. Cruz,[16]

2nd Gen paper on its way to publication
(to be submitted to PRD)

At the End of TeVatron Run II

<u>Assumptions:</u>

Same acceptances as now

Number of events observed = number of predicted background

Same errors

β= 1 mass limit up to 250-300 GeV/c^2

β = 0.5 mass limit up to 230-280 GeV/c^2

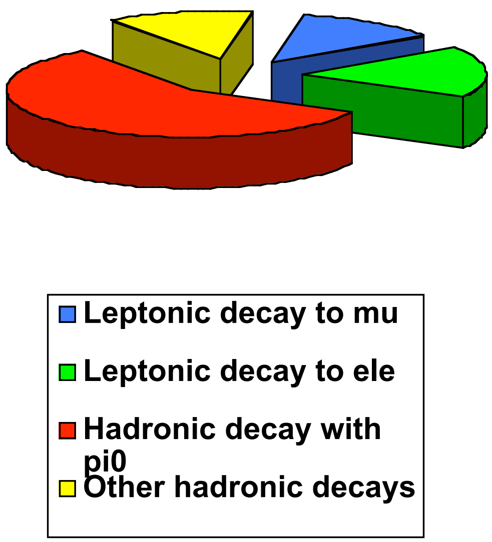
Preliminary

New analysis strategy
(not counting experiment anymore?)
might be necessary…….

Current Activity and Plans

Tufts is the only institution in CDF doing LQ's

- Third generation LQ's
  - <u>LQ→τb</u>
  - Leptonic decay of both taus will be considered first
    - Lower BR but cleaner signature (high P_T) lepton triggers



- Hadronic ~65%
- Leptonic ~35%
  - $\tau \rightarrow e$ 17.84%
  - $\tau \rightarrow \mu$ 17.36%

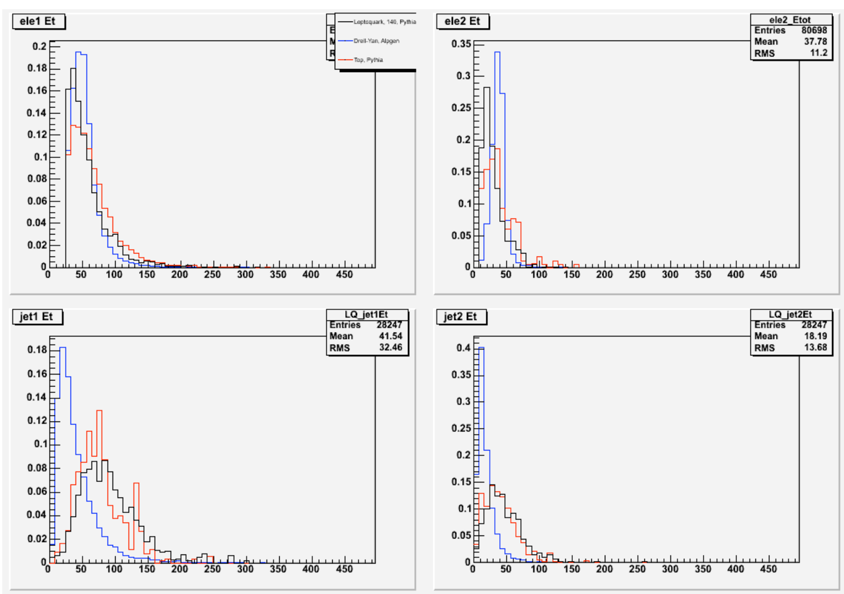
Signal and Background MC study

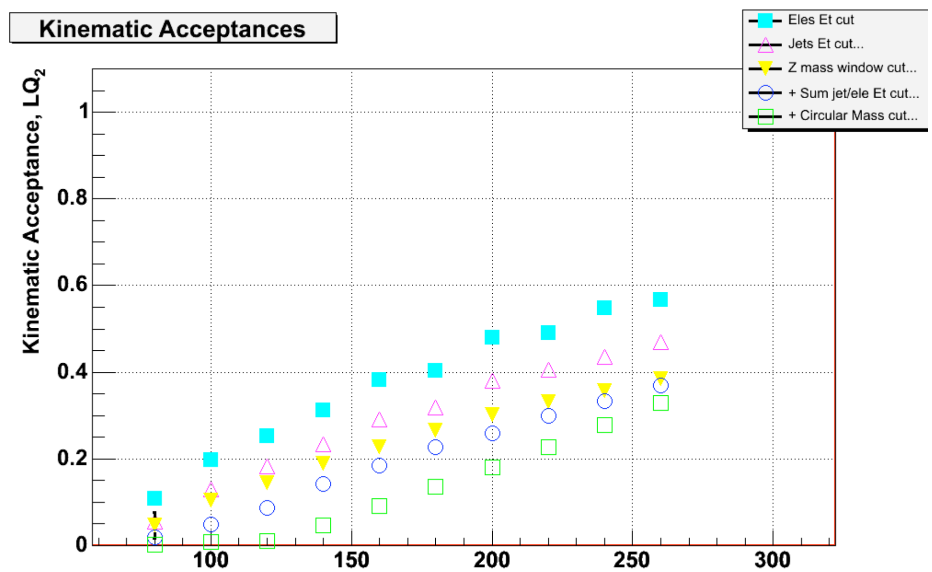
- Background Monte Carlo
  - Drell-Yan with 2 jets, where $Z/\gamma^* \rightarrow e^+e^-$
  - Top production where both W decaying leptonically
  - Inclusive $Z \rightarrow ee/\tau\tau$
  - QCD fake events cannot be simulated, they will be estimated by studying the real data

- Selection strategy
  - Kinematical selection criteria
    - 1 tight ID ele, plus 1 medium ID ele
    - 2 jets with E_T (j1) > 30 Gev, E_T (j2) > 15 Gev
    - Events with M_{ee} out of Z mass window [75,105]
    - E_T (e1) + E_T (e2) > 50 Gev, E_T (j1) + E_T (j2) > 85 Gev
    - Circular cut sqrt [$(E_{T\,e1} + E_{T\,e2})^2 + (E_{T\,j1} + E_{T\,j2})^2$] > 200 Gev

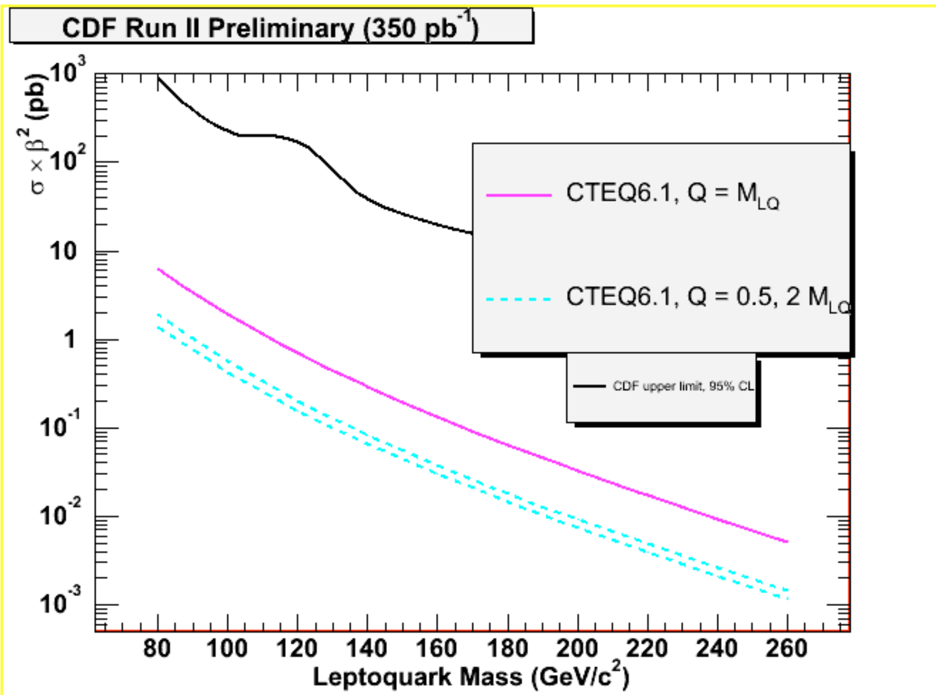
Results

- Total background N_exp ≈ 22.508
- Signal acceptance from 0.2% to 33%
- S/B ~ o (1/10), still needs to be improved!





Limit cross section and preliminary conclusions



Unless we control the background to the level ≤ 15 events, boost the signal selection efficiency up to 8% @ 80Gev, at 1 fb-1 we probably could get an upper limit.

Exploring the <u>possibility of using b-tagging:</u>

signal acceptance should boost and background being greatly reduced

Work is in progress (Hao's thesis)

Physics at LHC

Les Houches 2005

• Fourth in a series whose aim is to **bring together theorists and experimentalists** working on the phenomenology of the upcoming **TeV colliders** .
• The emphasis will be on the **physics of the LHC during its first few years of running**
  • Strong interplay between:
    • what has been learned from the TeVatron
    • how the next linear collider could complement LHC measurements/findings
  • The impact of cosmology and astrophysics will be addressed.
  • Two WG - convener of BSM

The projects are to start in January 2005 and should be completed by the end of the year 2005.

TeV4LHC Workshop

• Bringing together the Tevatron and LHC experimental groups and the theoretical community to make the best possible use of data and experience from the Tevatron in preparing for the LHC experimental program:
  • Understanding how to use Tevatron data to improve event modelling
  • Theoretical understanding of cross sections for the signals and backgrounds at LHC,
  • Using experience with real problems at the Tevatron

ATLAS Physics Workshop - Rome, June 2006

Physics at ATLAS

Two areas of interest:
Exotics Group: LQ search sensitivity
Top Group: Single Top

Work done in the framework
of the Rome Physics Workshop
and with the intention of publishing
Scientific Notes later in 2006

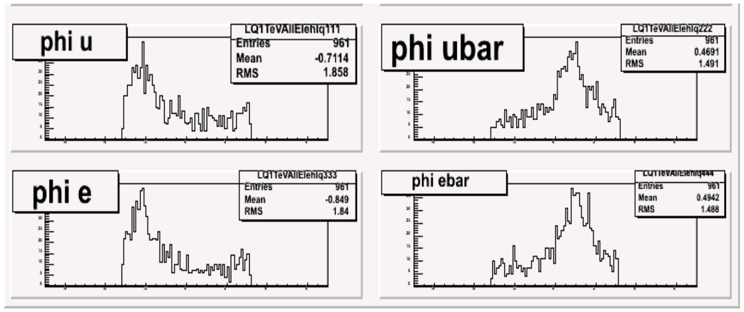
Collaboration with:
Columbia (LQ)
Udine (SingleTop)

Leptoquarks in ATLAS

LQ sensitivity will extedn at LHC to masses up to 1.5 TeV/c^2
Pair production is still the dominant process contributing to the cross section.

In the framework of the Rome workshop, we studied the signal
Detection efficiency for 2 set of masses, 0.5TeV and 1 TeV
The samples were suffering from a generation problem, but very
Preliminary results could be derived.

Generator Level ϕ distribution

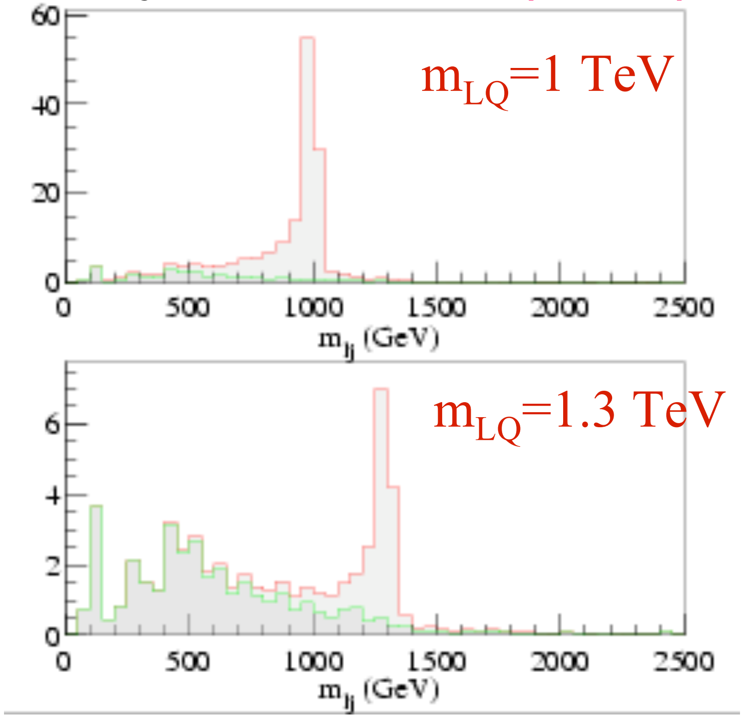


LQ in ATLAS

- Previous Results:
  - Fast simulation: Scalar LQ
    - LQ LQ → $\ell^+ q \ell^- q$ and nqnq
    - 2 jets+2 leptons: 1st and 2nd generation
      - High Pt isolation + High m_{lj} cut
      - → sensitivity: m_{LQ}=1.3 TeV
    - 2 leptons + Et: 3rd generation
      - *b*-jets+non isolated leptons+topo
      - → up to m_{LQ}~1.3 TeV

- Full simulation: in progress

2 jets + 2 leptons (30 fb^{-1})



Single Top in ATLAS

First Look at single-top cross-section measurements in Atlas with FullSim AOD's

Arnaud Lucotte

IN2P3/LPSC Grenoble

Thanks To :

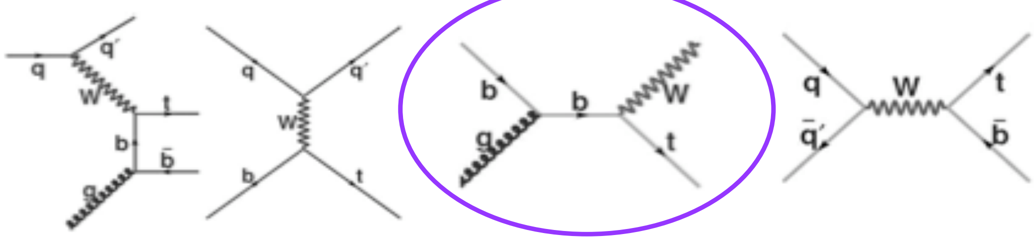
Within the Top Group :
- F. Chevallier (LPSC)
- M. Barisonzi (NiKHEF)
- M. Cobal, M.P. Giordani (Udine)
- S. Rolli (Tufts)
- C. Roda, I. Vivarelli (Pisa)

The Athena/PhysicsAnalysis/ Experts :
- K. Assamagan (BNL)
- S. Binet (Clermont-Ferrand)
- Production team, etc...

Single-top in the SM

- 3 production mechanisms

W-g (t-channel) W+t (Associated) W* (s-channel)



→ Two of them could be seen at theTeVatron (W*,Wg)

→ All will be measured *precisely* at the LHC

Motivations

- Properties of the Wtb vertex :
  - Determination of $\sigma(pp \to tX)$, $\Gamma(t \to Wb)$
  - Direct determination of $|V_{tb}|$
  - Top polarization
- Precision measurements → probe to new physics
  - Anomalous couplings, FCNC → t-channel,W+t
  - Extra gauge-bosons W' (GUT, KK)
  - Extra Higgs boson (2HDM) → s-channel
- Single-top is one of the main background to ...

  ... Higgs physics with jets...

Selection efficiency

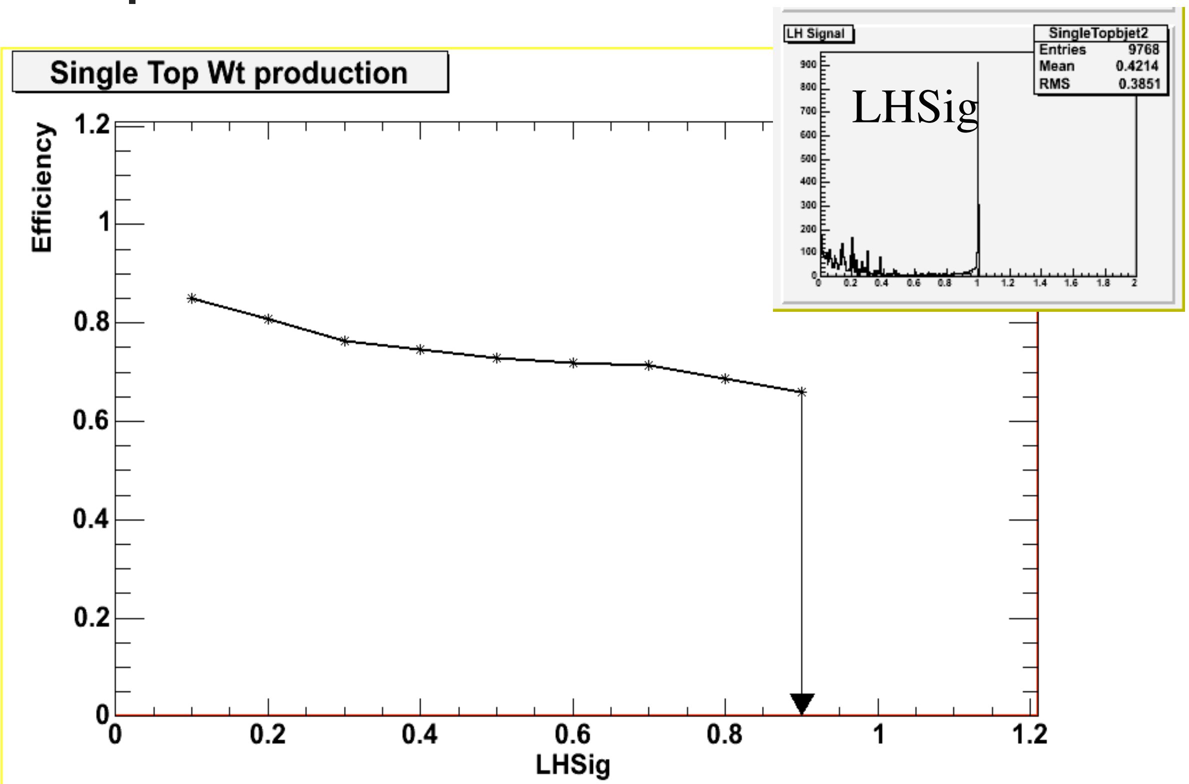
ε(%)	W+t FullSim	W+t TDR
Total processed	--	
N(ele)=1, p_T>20	49.5	
p_T(e)>20, mE_T>20	44.3	
N(b-jet) = 1, p_T>50	18,7	
N(jet) = 2, p_T>30	8.98	
60 < m_{jj} < 95	0.93	1.27

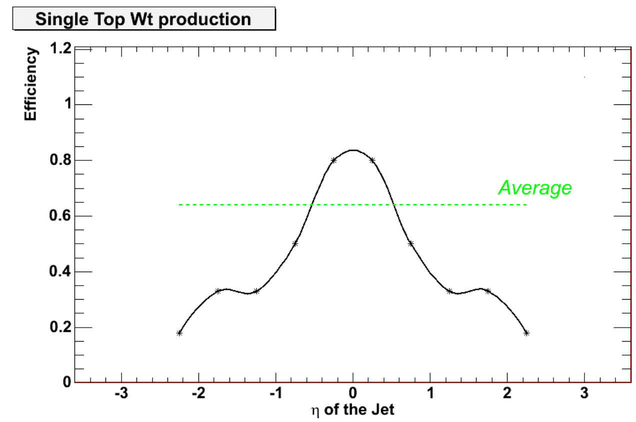
M. Cobal, Giordani, Rolli, C. Roda

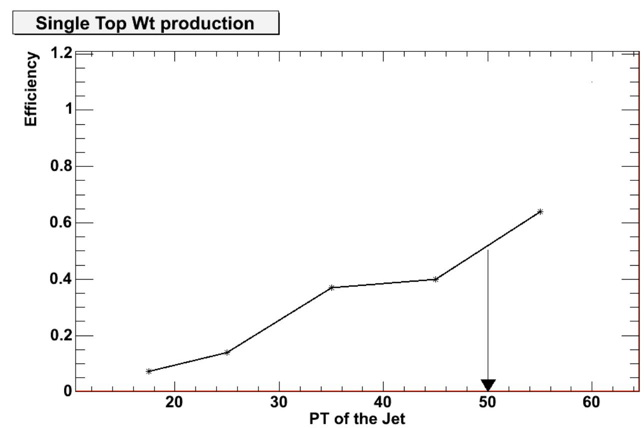
Single Top: b-tagging studies

- ATLAS Historical » taggers:
  - **IP2D**: transverse impact parameter
  - **IP3D**: 2D+longitudinal
  - **SV1, SV2**: inclusive secondary vertex **SV1+IP3D** (called SV1 in CBNT)
- New taggers:
  - Lifetime2D: transverse impact parameter
  - **lhSig**: secondary vertex + impact parameter (2D&3D)
- Tagging weight:
  - IP2D: based on impact parameter significances $S=d_0/\sigma(d_0)$
  - Track weight: likelihood ratio $w_t=P_b(S)/P_u(S)$
  - Jet weight: $W_j= \Sigma \ln w_t^i$
- Generalization of the weight for other taggers, can be combined by summing them up.

Btagging Efficiency - Rome





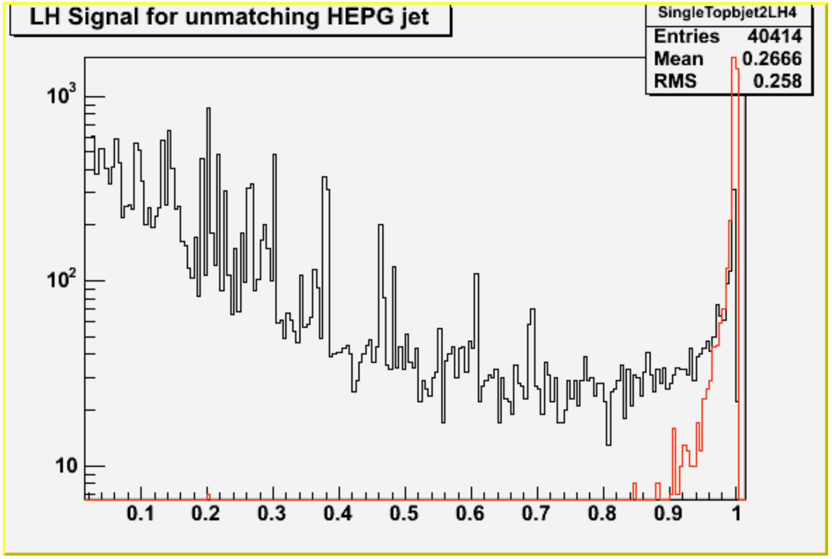


B-tag efficiencies - After Rome

Suggestion to check other taggers: <u>SV1, IP2D and IP3D</u>
LHSig (cut at 0.9) is more efficient than the other algorithms (cut at 3.0)

We tested various value of the cut , from 1 to 9 and compared with lhSig.

LHSig distribution:
IP2D > 3.0 (red)
IP2D < 1.0 (black)

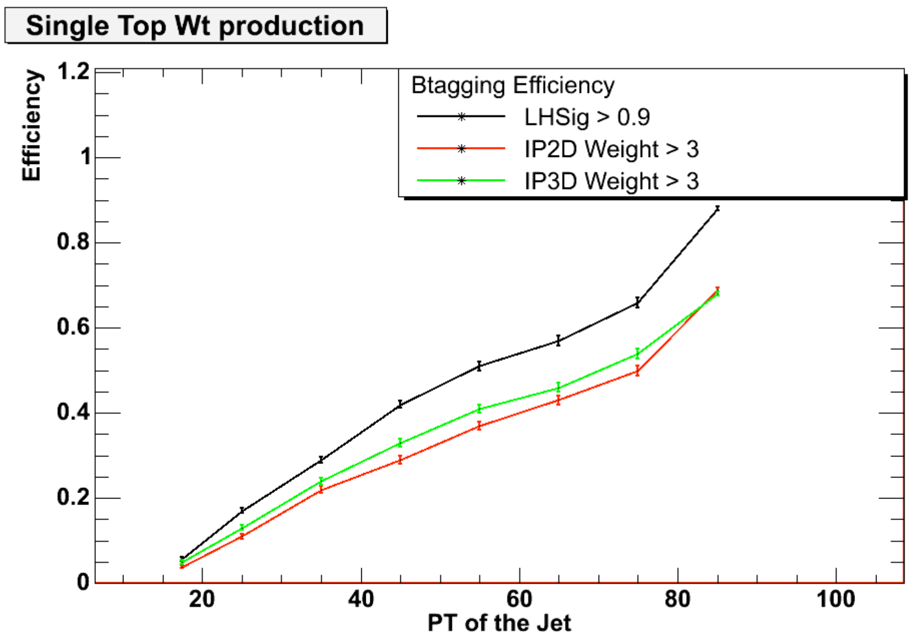


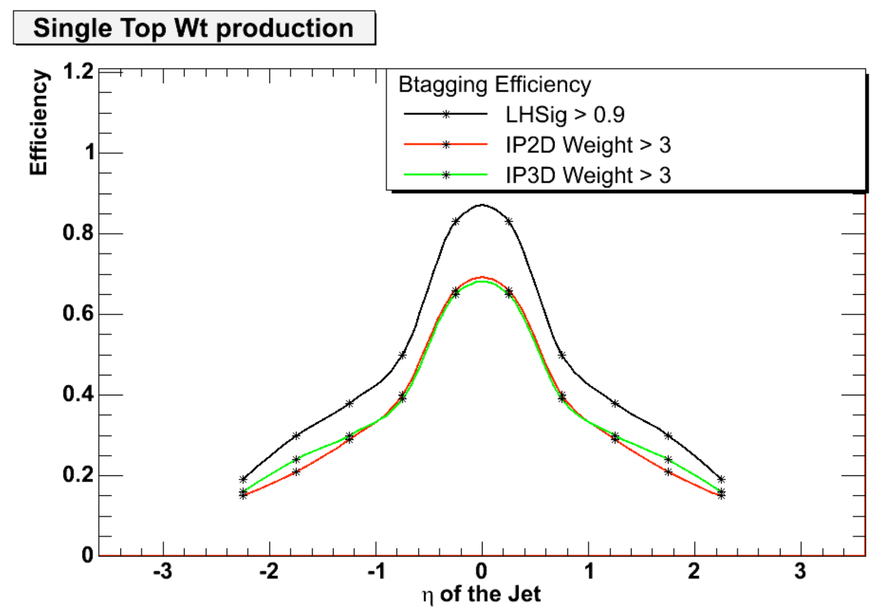
B-tag efficiencies

Efficiencies are calculated in the following way:
Denominator: number of jets matched with the b-parton, with $P_T > 50$ GeV, $\eta < 2.5$
Numerator: ditto with cut on weight/likelihood

IP2D/IP3D Cut	Eff Ip2D	Eff IP3D	SV1 Cut	Eff SV1	LHSig cut	Eff LHsig
1	0.60	0.61	1	0.54	0.1	0.80
2	0.54	0.56	2	0.51	0.2	0.76
3	0.49	0.50	3	0.48	0.3	0.72
4	0.43	0.45	4	0.44	0.4	0.70
5	0.38	0.41	5	0.40	0.5	0.68
6	0.33	0.37	6	0.34	0.6	0.67
7	0.29	0.32	7	0.28	0.7	0.65
8	0.25	0.26	8	0.21	0.8	0.63
9	0.21	0.25	9	0.14	0.9	0.60

B-tag efficiencies: comparisons

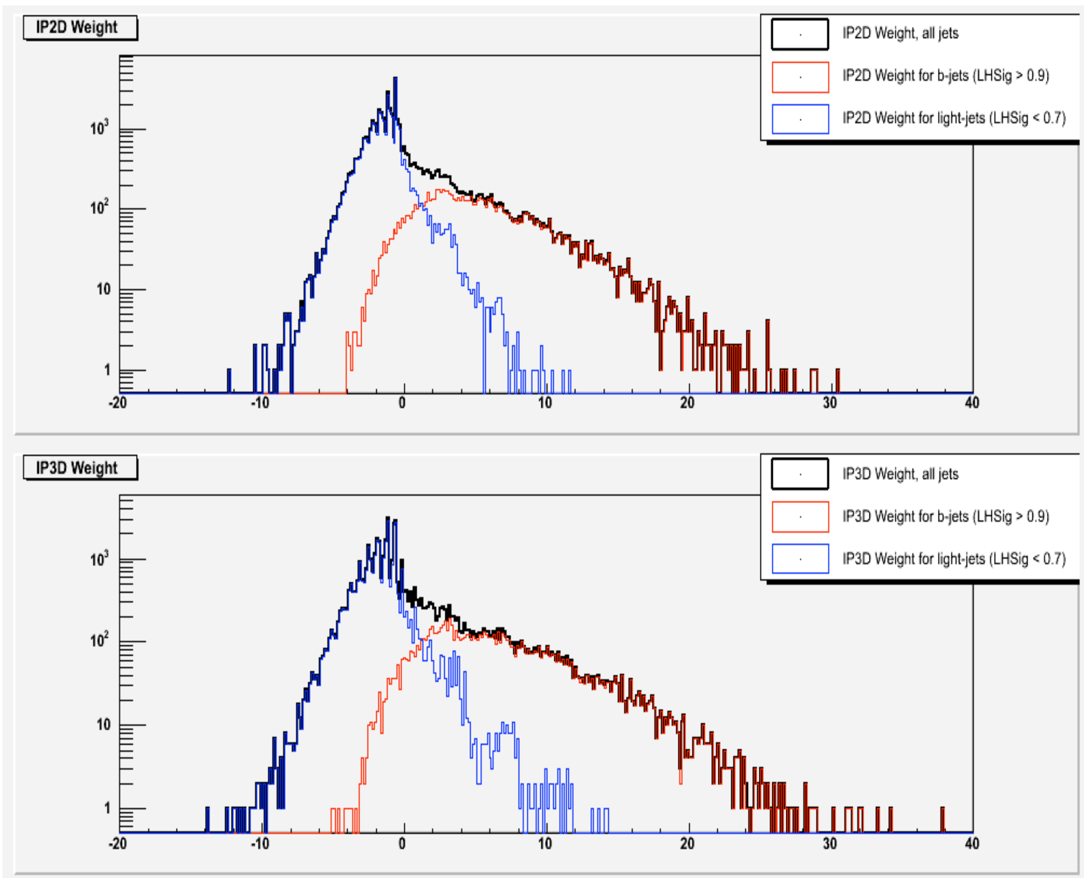


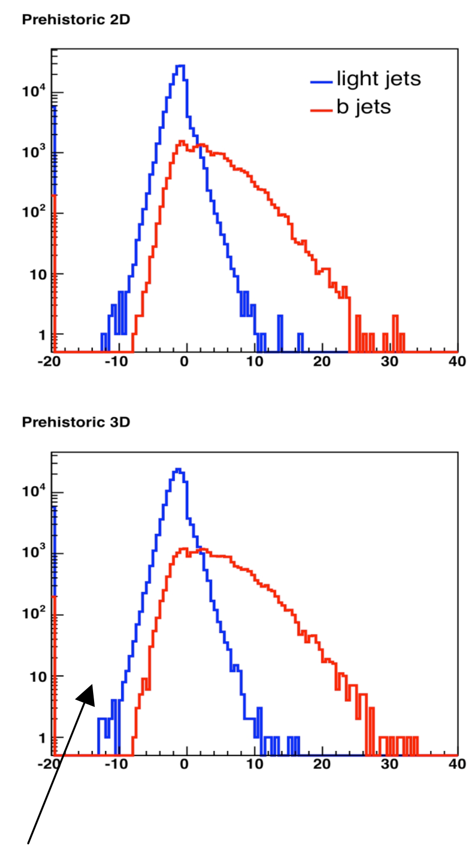


b-tagging performance estimators

- b-jet efficiency ε_b:
  - Denominator:
    - jets defined as b using MC truth → jets defined using LHSig > 0.9
    - with (raw) p_T>15 GeV/c, $|\eta|$<2.5
    - NB: jets with no "good" tracks for b-tagging **are** included
    - NB: iso. electrons are not present in the JetTag collection (.)
  - Numerator:
    - ditto + cut on a tagging weight
- light-jet rejection $R_u = 1 / \varepsilon_u$ jets defined using LHSig < 0.7
  - R=100 means 1% mistag rate
  - light jets: u, d, s, g

Weights





From the Flavour Tagging Validation Twiki page

Light Weight rejection

Process Dependent

	R_u (ε_b = 50%)	R_u (ε_b = 60%)
IP2D	125 (158 -109)	50 (55-57)
IP3D	200 (228-130)	100 (86-66)
IP3D + SV1	200 (505-325)	111 (184-156)

WH sample (L.V.)

ttbar sample (L.V.)

Wt (S.R)

Conclusions on b-tagging

•B-Tag studies on Wt samples:

- Preliminary tests on various b-tag algorithms, as out of the box on Rome samples for single top were performed
- Generally good agreement with previous studies (L.V.)
- LHSig seems the most powerful flag to use to select b-jets (LHSig > 0.9) in Wt data
- More studies will be done
- Work ongoing within the b-tag group: goal is to select the best algorithm for the analysis.

Conclusions on ATLAS work

The analysis framework is well developed in ATLAS

Tools are well advanced and easy to use

The analysis ability is still very much in its infancy:

many people with LEP experience

few TeVatron people starting working actively

It is important to step in now and contribute with experience from the TeVatron

Still the collaboration is oversubscribed….

Talks and Presentations

- Simona Rolli, Fermilab Joint Theoretical-Experimental Seminar, April 2004
  - Recent Results on EW, Top and Exotic Physics at CDF
- S.Rolli, I.F.A.E. Torino, April 2004
  - Recent Results on Exotic Physics at the TeVatron
- S. Rolli, R.T.N, Pisa May 2004
  - Recent Results on Exotic Physics at CDF
- S. Rolli, Tev4LHC workshop, Fermilab September 2004
  - Searches fo LetpoQuarks

Other Talks and Presentations

- Simona Rolli

Central Michigan University Lecture, November 2004

BNL, HEP Seminar, January 2005

University of Michigan, HEP Seminar, March 2005

University of Pisa/INFN, HEP Seminar, May 2005

University of Udine, HEP Seminar, May 2005

  - Recent Results on High P_T Physics at CDF

- Simona Rolli, University of Udine, October 2005
  - Tutorial on AOD use in the ATLAS experiment